Original Research Paper

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Radiodiagnosis

ROLE OF CROSS SECTIONAL IMAGING IN SENSORINEURAL HEARING LOSS

Dr. Manu Gupta	Assistant Professor, Department of radiodiagnosis, mahatma gandhi university of medical sciences and technology, Jaipur.
Dr. Karan Jyani	Resident, Department of radiodiagnosis, mahatma gandhi university of medical sciences and technology, Jaipur.
Dr. Bhumika Luniwal	Resident, Department of radiodiagnosis, mahatma gandhi university of medical sciences and technology, Jaipur.
Dr. Heera Ram	Assistant Professor, Department of radiodiagnosis, mahatma gandhi university of medical sciences and technology, Jaipur.
Dr. Hemnat Kumar Mishra	Professor And Head, Department of radiodiagnosis, mahatma gandhi university of medical sciences and technology, Jaipur.

ABSTRACT **Purpose:** Aims and objective of the study is to determine the incidence of structural cochlear anomalies in Sensorineural hearing loss and to evaluate them using HRCT and MRI Scan of temporal bone to asses feasibility of cochlear implantation. **Method:** The study was carried out in the department of radiodiagnosis over a period of 16 months. The study included 114 patients of moderate to profound SNHL to evaluate further using HRCT and MRI Scan of temporal bone. **Results:** Out of total 114 pts in our study 75 pts had normal CT/MRI of temporal bone with no structural abnormalities detected and 39 number of patients had structural malformations which were feasible for cochlear implantation. Small percentage of patients (11%) with common cavity and absent cochlear nerve were not feasible for cochlear implantation. **Conclusion:** HRCT and MR imaging play an important role in evaluation of congenital hearing loss by providing crucial information about the inner ear, vestibulocochlear nerve, and brain. Both modalities precisely and accurately delineate the inner ear anatomy and malformations preoperatively in cochlear implant patients.

KEYWORDS : SNHL, HRCT, MRI

INTRODUCTION

Deafness is a major concern to the health care system of the entire world. The predominance of deafness in southeast -asia ranging from 4.6-8.8%. There are three types of hearing loss conductive, sensorineural hearing loss and mixed type. Conductive hearing loss represents a problem of conduction of sound waves in external ear, tympanic membrane, ossicles. SNHL represents deafness due to inner ear or retrocochlear / nerve abnormality. Imaging plays an important role before cochlear implantation in patients of SNHL.

Imaging provides vital pre-operative information about anatomy of ear, brain & vestibulocochlear nerve. HRCT temporal bone and MRI provide excellent delineation of the complex anatomy of inner ear. CT depicts the minute details of osseous structures and MR imaging allows visualisation of the fluid filled spaces & the vestibulocochlear nerve. Adults with asymmetric or unilateral SNHL often undergo gadolinium enhanced MR imaging of the brain with attention to the internal auditory canals to evaluate for retro-cochlear abnormalities.

MATERIALS AND METHODS:

The study was conducted in the department of radiodiagnosis and patients with congenitally diagnosed SNHL and patients with acquired causes of SNHL upto the age of 18 years were included in the study. Patients who declined to give written informed consent and patients with conductive hearing loss were excluded from the study.

Study comprised of 114 patients and all of the patients were subjected to undergo CT scan and MRI scanning after obtaining a written and informed consent on 64 slice CT machine and 1.5 T MRI scanner. The HRCT technique used included axial helical acquisitions with a collimation of 0.6 mm, 5mm section thickness, and magnified axial and coronal 3-mm reconstructions with the use of an enhanced edge bone algorithm with KV 120, mAs 250, mA36, slice thickness 5 mm, resolution 512x512 . Reconstructed image in 0.625mm.

On MR imaging coronal images were obtained perpendicular to the axial planes from the cochlea to the posterior semicircular canal. Continuous 0.5–1 mm-thin slices were obtained at 1 mm interval using ultrahigh algorithm with a scan time of 20 s with a delay of 4 s at 120 kV tube voltage and 400 mAs. TR1200, TE 265, TA 6.39, resolution 512x512.

The scans was analyzed and structural malformation detected were recorded on prestructured proforma for the study and all stastical analysis was done using the SPSS 20 software. Microsoft excel was used to prepare the master charts.

OBSERVATIONS AND RESULT:

Majority of the patients included in the study were in the age group of 3 to 4 years (41%) followed by 5-6 yrs (33%). Only 9% of patients presented in age group more than 7 years. Mean age of the patients being 4.2 years with no significant sex predilection.

Patients on basis of inner ear abnormalities detected on CT and MRI were divided into 2 groups where 66% of the patients with clinically diagnosed SNHL showed no abnormality in inner ear on CT/MRI scans whereas 34% of patients had detectable abnormality of inner ear.

Patients with abnormality in inner ear were distributed into 7 groups on the basis of structural malformation detected on CT/MRI out of which Cochlear abnormalities (56%) were most common abnormality detected followed by vestibular aqueduct (41%) and SCC abnormality (38%).

Distribution of abnormal patients (N=39) on the basis of various types of inner ear malformation detected.

S. No	Structural Abnormality	No. of Malformation	Percentages (%)
1	Cochlear Abnormality	22	56
2	Vestibular aqueduct abnormality	16	41
3	Semicircular abnormality	15	38
4	IAC Abnormality	10	25
5	Cochlear Nerve absent	10	25
6	Facial Nerve absent	05	13
7	Endolymphatic Duct Dilated	11	28

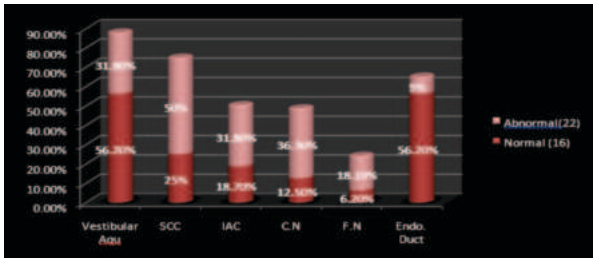
Cochlear abnormalities were divided into the following subtypes –

S.No.	Cochlea	No. of Patients	Percentages (%)
1	Common Cavity	07	32
2	Incomplete Partition T 1	03	14

3	Incomplete Partition T 2	06	27
4	Hypoplastic	02	09
5	Cochlear Ossificans	03	14
6	Absent	01	04
	Total	22	100

Vestibular aqueduct was dilated in 87% cases whereas vestibular aqueduct was absent in 13% of cases. Among SCC abnormalities, Hypoplastic SCC was the most common SCC anomaly accounting for 73% followed by aplasia of SCC 13%.

IAC abnormalities were found in 10 patients and were divided into 2 subtypes (Narrowed and dilated) with statistical significant correlation ($p<0.05$) between narrow IAC and absence of cochlear nerve; with cochlear nerve absent in 4 out of 5 cases of narrow IAC. Patients with detected cochlear abnormalities were analyzed for coexisting other structural malformation of inner ear and high association between coexisting cochlear and SCC abnormalities was observed in 50%. Coexisting cochlear and vestibular aqueduct abnormalities were present in 31.8% whereas coexisting cochlear and cochlear nerve abnormalities were present in 36.3 % of cases.



Feasibility for Cochlear implantation:

Out of 114 patient, 75 patients had no structural abnormality detected and hence were feasible for cochlear implantation. 7 patients with common cavity were not feasible for cochlear implantation; one patient had absent cochlea as well as cochlear nerve. 5 patients had absent cochlear nerve hence . So in,total out of 114 patients ,13 patients were on basis of imaging not feasible for cochlear implantation.

S. No.	Structural abnormality detected on CT/MRI	No. of patients	Feasibility for Cochlear implantation
1	Normal	(75)	Feasible
2	Abnormal	(39)	
A)	Cochlear Abnormality	(22)	
I)	Common Cavity	(07)	Not Feasible
ii)	Incomplete Partition T 1	(03)	Feasible
iii)	Incomplete Partition T 2	(06)	Feasible
iv)	Hypoplastic	(02)	Feasible
v)	Cochlear Ossificans	(03)	Feasible
vi)	Absent	(01)	Not Feasible
B)	SCC Abnormality	(15)	
i)	Hypoplastic	(11)	Feasible
ii)	Common Cavity	(01)	Feasible
iii)	Dilated	(01)	Feasible
iv)	Absent	(02)	Feasible
C)	Vestibular Aqueduct Abnormality	(16)	
i)	Dilated	(14)	Feasible
ii)	Absent	(02)	Feasible
(D)	Endolymphatic Duct Dilated	(11)	Feasible
(E)	Cochlear Nerve Absent	(10)	Not Feasible

Image Gallery

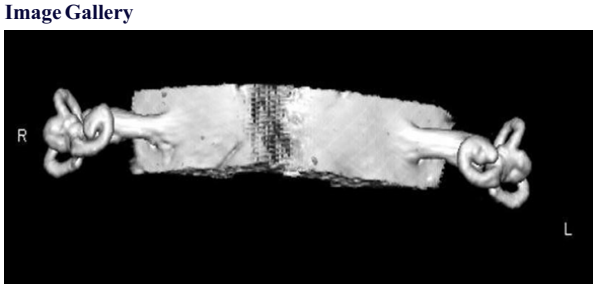


Figure 1: Coronal 3D VRT image showing bilateral deficient apical turn with hypoplasia of Lateral Semicircular Canals (Incomplete partition type II)

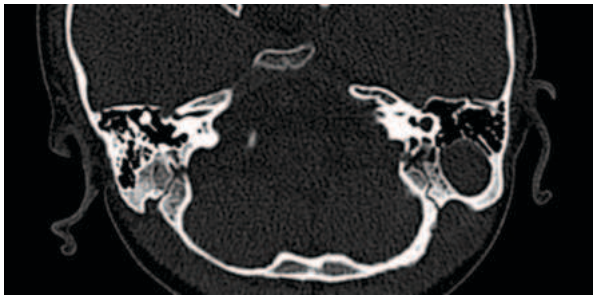


Figure 2: Axial CT image showing right cochlear aplasia and left common cavity.

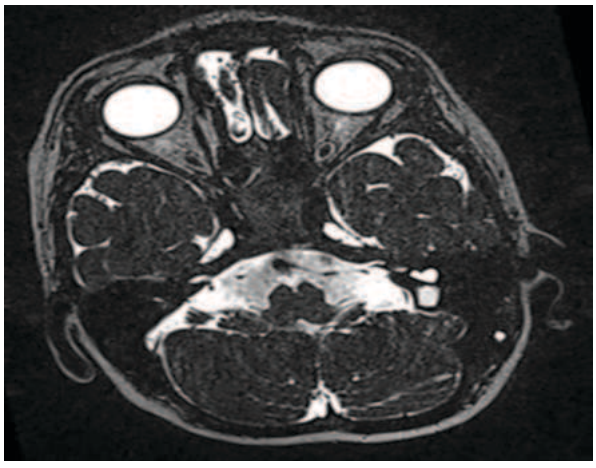


Figure 3: Axial T2W MR image showing small IAC.

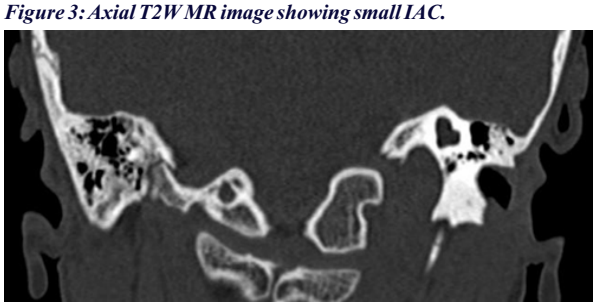


Figure 4: Coronal CT image showing left common cavity.

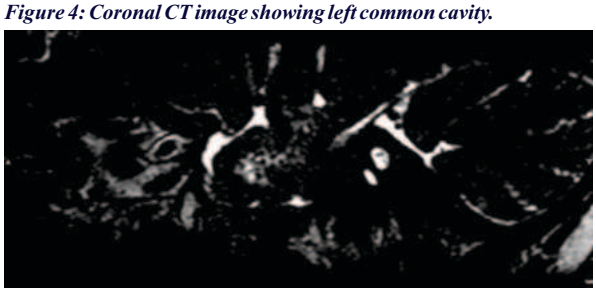


Figure 5: Sagittal T2W MR image showing absent cochlear nerve in same patient.

DISCUSSION:

Sensorineural hearing loss represents deafness due to inner ear or retrocochlear abnormality or malfunctioning. The aetiology of these abnormalities may be congenital or acquired. Congenital inner ear abnormalities are outcome of the arrest of inner ear development in fetus due to various environmental and genetic factors with more extensive malformations occurring due to insult during 3rd to 6th weeks of gestational age.(1)

Imaging provides vital information about inner ear structural malformation and possible aetiologies for inner ear malfunction. HRCT and MRI provide excellent delineation of the complex anatomy of inner ear. Availability of 3D Volume Rendering Technique is an aid

in diagnosis, as these images had potential to display normal and malformed inner ears clearly and confirm the site and degree of even smaller malformation at different visual angles.

Cochlear implantation is an acceptable treatment in SNHL patients. Hence pre-operative assessment of inner ear structural malformation by imaging has become an integral part to know the feasibility of cochlear implantation and prognostication.

A total of 114 patients with bilateral severe SNHL were included in the study fulfilling inclusion and exclusion criteria's. All the patients in our study group were of congenital SNHL.

Mean age of patients in our study was 4.23 yrs with majority of patients being in the age group of 3 to 4(41%) followed by 5-6 yrs (33%). Only 9% of patients presented in age group more than 7 years with no sex predilection as 51% were female and 49% males.

Out of total 114 patients, we found 39 patients (34%) having radiological inner ear abnormality

Cochlear abnormalities were maximum and accounted for 56% of cases out of all structural abnormalities of inner ear, and out of all cochlear malformation patients (56%), most of the patients had common cavity 32%, followed by incomplete partition type II - 27%, incomplete partition type I -14%, cochlear ossificans-14%, cochlear hypoplasia in 9%, and cochlear aplasia in 4% of the patients.(3)

We found 41% patients have vestibular aqueduct abnormality, of which dilated vestibular aqueduct was most common.

In our study, there was a significant correlation (p value<0.05) between diameter of IAC and presence/absence of cochlear nerve. Cochlear nerve was found to be absent/hypoplastic in 4 out of 5 patients with narrowed IAC (<2mm). Cochlear nerve was found absent in 6 patients out of 34 with normal IAC diameter.(6)

We found presence of more than one abnormality in many patients. There was high association between cochlear abnormalities and SCC abnormalities and was observed in 50% of cases. Cochlear, vestibular aqueduct and IAC abnormalities were coexistently present in 31.8% of cases. Cochlear abnormalities were associated with cochlear nerve abnormalities in 36.3 % cases. While endolymphatic duct dilatation was seen in 9% of cases of cochlear malformation. Facial nerve abnormalities were found in 13% of the cases in our study. Although facial nerve is not involved in hearing but it is important to comment on the course of facial nerve in patients planned for cochlear implantation so as to avoid injury to facial nerve during surgery. (5)

Out of total 114 pts in our study 75 pts had normal CT/MRI of temporal bone with no structural abnormalities detected and 39 number of patients had structural malformations which were feasible for cochlear implantation. Small percentage of patients (11%) with common cavity and absent cochlear nerve were not feasible for cochlear implantation.

We propose use of MRI in addition to HRCT in preoperative evaluation of cochlear implant candidates of SNHL. Bony structural abnormalities are nicely detected on HRCT, however evaluation of cochlear nerve by direct visualization by MRI is needed, as many cases with normal bony canal diameters may still have absence of cochlear nerve and hence not feasible for cochlear implantation**.**

CONCLUSION

HRCT and MR imaging play an important role in evaluation of congenital hearing loss by providing crucial information about the inner ear, vestibulocochlear nerve, and brain. Both modalities precisely and accurately delineate the inner ear anatomy and malformations. Preoperative HRCT offers the advantage of visualizing any coexistent inner, middle or external ear anomalies and important anatomic variants, and MR imaging provides definitive information about the integrity of the cochlear nerve and the fluid-filled spaces of the inner ear. We propose use of MRI in addition to HRCT in preoperative evaluation of cochlear implant candidates of SNHL.

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